(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 769 671 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.04.1997 Bulletin 1997/17

(51) Int Cl.[6]: **F41H 1/02**

(21) Application number: **96306816.8**

(22) Date of filing: **19.09.1996**

(84) Designated Contracting States:
BE DE ES FR GB IT NL SE

(30) Priority: **23.09.1995 GB 9519467**
03.05.1996 GB 9609333

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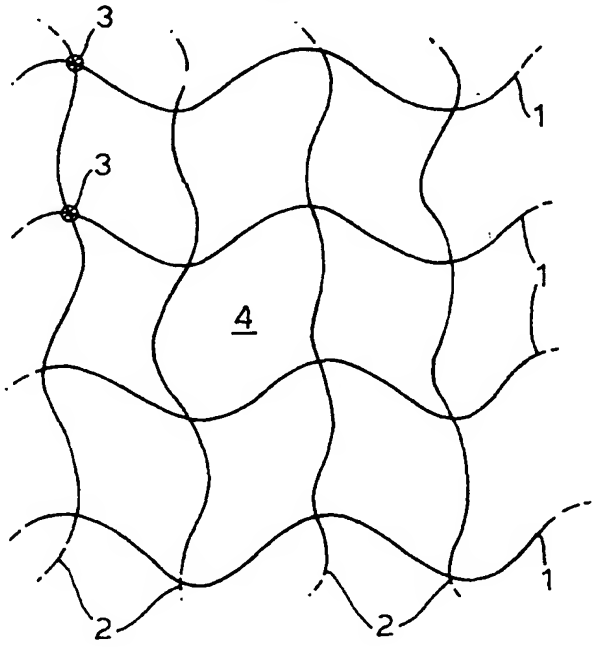
(54) Anti-stab material

(57) Anti-stab material comprises a set of metal strands (1) secured to a non-metallic support fabric (2). All the metal strands (1) in the material are substantially unidirectional.

Fig.1.



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Printed by Jouve, 75001 PARIS (FR)

Description

The invention relates to anti-stab material and to the use of such a material in body armour.

There have been many types of anti-stab material devised in the past for protecting the human body from stab attacks using sharp weapons such as knives, stilettos and the like. An ancient approach to this was to make use of chainmail and this has been an approach which has been followed to the present day using wire mesh arrangements. However, in the case of body armour, there is a need to provide a material which can protect the wearer against modern weapons but which is lightweight so that it can be worn comfortably and allow maximum freedom of movement for the wearer. The problem with wire mesh is that it leads to a very bulky and heavy material which is uncomfortable to wear and restricts movement of the wearer.

Examples of previous constructions of body armour utilising wire mesh and the like are described in US-A-3826172, GB-A-2124887, GB-A-2232063, JP-A-62029899 and JP-A-1-244299.

In accordance with the present invention, we provide anti-stab material comprising a set of metal strands secured to a non-metallic support fabric, wherein all the metal strands in the material are substantially unidirectional.

We have found that it is not necessary to provide a complete mesh of metal wires or strands to achieve adequate anti-stab protection. Instead, a fabric in which the metal strands are substantially unidirectional provides good stab resistance to most known weapons used by a human attacker. By providing the support fabric of a non-metallic material, the weight of the anti-stab material is minimised thus leading to a very lightweight and comfortable protective material.

The spacing of the metal strands is chosen depending on a variety of factors such as the strand thickness and the type of weapons to which the material is intended to be resistant. Typically, the strand centres are spaced apart by less than 10mm, preferably less than 6mm, and most preferably in the range 2-4mm or 2.5-5mm. In some cases, the adjacent strands could touch.

In some cases, the metal strands can be bonded to a single support fabric sheet using a suitable adhesive such as a resin adhesive. However, in a more preferred arrangement, the metal strands are sandwiched between two sheets of the non-metallic support fabric. This provides greater support for the strands so that they are more effective at withstanding a blade attack.

In the most preferred arrangement, however, the metal strands are woven to strands of the support material. For example, the metal strands could comprise the warp in the woven material, the weft being made from strands of a non-metallic support fabric, for example nylon or aramid. A woven arrangement provides inherent strength and resistance to lateral movement between the metal strands although typically the strands will be additionally bonded to the non-metallic support fabric to provide additional security against relative movement.

The metal strands typically comprise twisted metal filaments and typically have a diameter of less than 1mm. Such strands will have a high tensile breaking strength which is preferably not less than 2.5N/mm^2 and a breaking point not less than 1500N.

A layer of the anti-stab material according to the invention will provide good resistance to stab attack but in preferred arrangements, at least two layers of the anti-stab material are formed into an anti-stab structure, the strands in each layer extending in a direction different from the strands in the other layer(s).

In one example, three layers of the anti-stab material are provided, the strands in two of the layers extending at + 30° on either side respectively of an orthogonal to the strands of the third layer. In another example, three layers of the anti-stab material are provided, the strands in two of the layers extending at ± 45° on either side respectively of an orthogonal to the strands of the third layer.

The anti-stab material can be used by itself in some circumstances but conveniently is incorporated into body armour which further comprises a ballistic resistance pack. The construction of the ballistic resistance pack can be of any conventional form and will typically comprise a trauma pack and multiple layers of ballistic fabrics such as Kevlar.

An example of anti-stab material according to the invention and body armour incorporating such material will now be described with reference to the accompanying drawings, in which:-

Figure 1 is an enlarged, schematic view of the material;

Figure 2 is an exploded view, not to scale, of body armour incorporating the material shown in Figure 1; and,

Figures 3A-3C illustrate in more detail the three anti-stab layers shown in Figure 2.

Figure 1 illustrates in very enlarged, schematic form the appearance of the woven, anti-stab material. This comprises a set of unidirectional metal strands 1 woven with a set of unidirectional non-metallic strands 2. The non-metallic strands typically comprise strands of nylon or aramid fibres while the metal strands 1 are formed, in this example, from 0.7% carbon steel which has been hot dipped galvanised. Each metal strand is constructed from three twisted subsidiary strands each of seven twisted wire filaments 0.18mm in diameter to provide a finished strand having a diameter of about 0.91mm. Typically, the diameter of each strand is in the range 0.4-1.5mm. The metal strands have a tensile strength of 2650N/mm^2 and a breaking point of 1530N.

Although the woven nature of the fabric shown in

Figure 1 will maintain the strands 1,2 generally fixed relative to one another, additional strength is provided by bonding the strands together at their crossover points as indicated at 3. Typically, a resin adhesive is used such as Bostik (Registered Trademark). As alternatives to the resin adhesives, other methods of bonding the strands include the use of hot melt films and water based PVA adhesives. The spacing between centres of the adjacent metal strands 1 is typically less than 6mm and in the preferred arrangement in the range 2-4mm.

When the fabric is subject to a stab attack, the point of the blade will pass into a region 4 surrounded by the metal and non-metal strands 1,2. The strands will bend allowing partial entry of the blade but this bending will only be to a limited extent so that as the blade passes into the gap 4 and wider parts of the blade enter the gap 4, the blade will be restrained. Arrows 15 illustrate typical stab attack directions.

A single sheet of the anti-stab material shown in Figure 1 will provide some resistance to stab attack but in preferred arrangements, more than one sheet is provided. Figure 2 illustrates schematically the construction of a layer of body armour having three layers of the anti-stab material 5-7. Each layer 5-7 is substantially identical with the other layers but the direction of the metal strands 1 differs between the layers. This can be seen most easily in Figures 3A-3C which illustrate layers 5-7 respectively. Each layer 5-7 has a similar shape with a main body portion 8 for covering the wearer's chest together with shoulder portions 9. The layer 5 (Figure 3A) has generally horizontally oriented metal strands 1. The layer 6 (Figure 3B) has the metal strands extending in a direction about -30° to the vertical, while the layer 7 (Figure 3C) has the metal strands 1 extending in the direction +30° to the vertical.

This three layer construction is particularly preferred and provides very effective resistance to stab attack. Thus, a blade entering the material layer 5 may partially pass through that layer 5 but will then be received in the layer 6 and possibly finally in the layer 7. Since the metal strands extend in different directions in each layer, they will provide resistance to movement of the blade from different angles and it has been found empirically that this arrangement achieves very significant protection.

In the body armour shown in Figure 2, the three layers 5-7 will be stitched together around their periphery as indicated at 10. The layers are positioned within a bag 11, typically made of nylon and constituting the outermost layer of the body armour. Positioned behind the layers 5-7 is a ballistic resistance pack 12 which can be formed in any conventional manner. For example, the ballistic pack 12 could comprise an interleaved construction of suitable ballistic fabrics such as Kevlar, Twaron or Dyneema (Registered Trademarks). In one construction, the ballistic pack 12 comprises nine layers of Dyneema interleaved with nine layers of Twaron. If desired, these multiple layers can be secured together by stitching such as quilt stitching (not shown in Figure 2).

Finally, positioned behind the ballistic pack 12, is a trauma pack 13 which also comprises a number of layers, for example 11 layers, of Kevlar. The wearer's body is shown schematically at 14. Typically, the trauma pack 13 will be stitched over the ballistic pack 12, usually along one edge.

Although the body armour shown in Figure 2 includes a ballistic pack 12, this could be omitted in some cases although usually it is desirable to include a trauma pack with the anti-stab material.

An alternative trauma pack comprises a felt pad typically made of a high tensile fibre felt and optionally including a rubber facing on the side facing the attack face of the body armour. It has been found that the addition of the rubber facing significantly improves the trauma resistance of the felt. An example of a suitable high tensile fibre felt is a polyester needle felt having a weight of 1520g/mm^2, a thickness of 5.3mm, a tear strength of 200/300daN and an extension at break of 100% as sold by Naish Felts Limited. The rubber facing may be of natural or synthetic rubber. The addition of the rubber facing has been found to be particularly beneficial in absorbing the kinetic energy of a ballistic missile.

The body armour will typically comprise a front panel as shown in Figure 2 and an equivalent back panel (not shown) connected via the shoulder portions 9.

In some examples, additional plies or layers of a silk-type fabric could be provided secured together by stitching along the sides behind the layer 7. This leaves the layers of silk free to move relative to each other which assists in absorbing the kinetic energy from ballistic missiles and additionally provides resistance to penetration by edged weapons such as knives, spikes etc.

Claims

1. Anti-stab material comprising a set of metal strands secured to a non-metallic support fabric, wherein all the metal strands in the material are substantially unidirectional.

2. A material according to claim 1, wherein the strands are spaced apart by less than 10mm.

3. A material according to claim 2, wherein the strands are spaced apart by less than 6mm.

4. A material according to claim 3, wherein the strands are spaced apart in the range 2-4mm.

5. A material according to any of claims 1 to 4, wherein the metal strands are sandwiched between two sheets of the non-metallic support fabric.

6. A material according to any of the preceding claims, wherein the metal strands are bonded to the support fabric.

7. A material according to claim 6, wherein the metal strands are bonded using a resin adhesive.

8. A material according to any of claims 1 to 4, wherein the metal strands are woven to strands of the support material.

9. A material according to any of the preceding claims, wherein the strands comprise twisted metal filaments.

10. A material according to any of the preceding claims, wherein the strands have a diameter in the range 0.4-1.5mm.

11. An anti-stab structure comprising at least two layers of anti-stab material according to any of the preceding claims, the strands in each layer extending in a direction different from the strands in the other layer (s).

12. A structure according to claim 11, wherein three layers of the anti-stab material are provided, the strands in two of the layers extending at ± 30° on either side respectively of an orthogonal to the strands of the third layer.

13. A structure according to claim 11, wherein three layers of the anti-stab material are provided, the strands in two of the layers extending at ± 45° on either side respectively of an orthogonal to the strands of the third layer.

14. Body armour comprising a layer of anti-stab material according to any of claims 1 to 10; and a ballistic resistance pack.

15. Body armour according to claim 14, wherein the ballistic resistance pack comprises a trauma pack and multiple layers of ballistic fabrics.

16. Body armour according to claim 15, wherein the ballistic fabrics comprise Kevlar.

17. Body armour according to any of claims 14 to 16 in the form of a vest.

Fig.1.

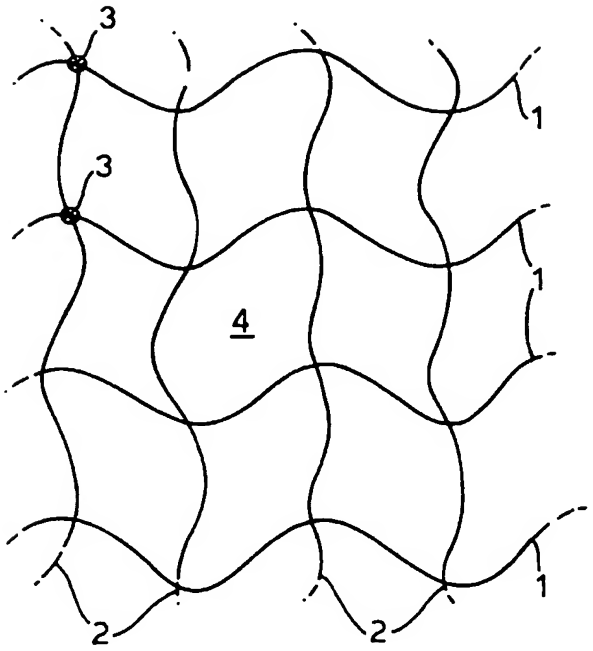

Fig.2.

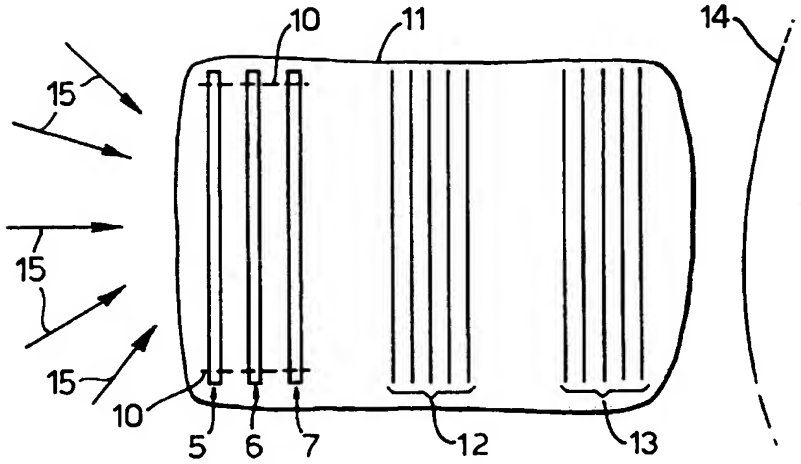

Fig.3.